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ON SOME RELATIONS BETWEEN THE PROPER MOTIONS, RADIAL VELOCITIES, AND MAGNITUDES OF STARS OF CLASSES B AND A.

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Attention was called in a former paper[1] to a decrease of proper motion with decreasing brightness in the class B stars, whereas the radial velocities showed an increase. Such a condition was found also in the class A stars, but more pronounced. Owing to lack of proper-motion data for the other classes the matter was not pursued. Since those results were obtained I have seen Kapteyn and Adams' investigation[2] in which they find that the radial velocities increase with increasing proper motion for the spectral classes F, G, K and M. The inference from the magnitude-results for classes B and A had been that the contrary was probably true for these two classes. It seemed that in general large radial velocities would be associated with large proper motions, and *vice versa*.

After seeing Kapteyn and Adams' results I classified the B–B5 and A stars according to proper motion and found that in fact their velocities do appear to decrease slightly with increase of proper motion. As stated, the contrary was found by Kapteyn and Adams for the classes F, G, K and M. The B8–B9 stars were classified separately. These 45 stars appear to follow the later types with respect to proper-motion velocity characteristics if we use the V_1 values, or the earlier B and A types if we use V. It is perhaps significant that the B8–B9 stars have been found not to have a large K term.

The relations of proper motion and radial velocity for classes B–B5, B8–B9 and A are given in Tables I and II. Table III contains the proper motions arranged according to visual magnitude.

Table I reveals an apparent relation of some kind between the magnitudes and proper motions of these three classes. The faintest stars are found *near* (but not in) the stars of very smallest proper motions in all. In both directions from these the magnitudes decrease numerically (stars become brighter). The differences, however, are small and so far as the first group is concerned, particularly in class A, may be accidental, although examination indicates considerable consistency. The V_1 of class B–B5 and V of classes B8–B9 and A show a similar effect for the radial velocities—the largest being *near* (but not in) the very smallest proper motions. Very noticeable is the sudden increase

TABLE I*

Arranged according to proper motion

CLASS	μ	MEAN MAGNITUDE	MEAN V_1	MEAN V	NUMBER OF STARS
			km.	*km.*	
B–B5......	0″.000 to 0″.009	4.0	6.2	8.9	38
	0.010 0.019	4.5	7.9	7.6	44
	0.020 0.029	4.2	6.7	8.9	28
	0.030 0.049	3.9	5.5	8.0	49
	0.050 0.119	3.7	4.4	6.0	23
B8–B9.....	0.000 to 0.019	4.2	4.4	3.1	9
	0.020 0.049	4.8	6.7	7.2	16
	0.050 0.099	4.6	7.8	6.8	17
	0.100 0.180	3.0	11.1	6.6	3
A.........	0.000 to 0.020	4.5		10.1	31
	0.021 0.050	4.6		12.4	47
	0.051 0.099	4.5		11.1	60
	0.100 0.199	4.1		10.4	53
	0.200 0.656	3.0		10.1	18

* These tables are based upon Campbell's catalogs of B and A class stars in *Lick. Obs. Bulletin,* Nos. 196 and 211.

TABLE II

Arranged according to radial velocity

CLASS	V_2	MEAN MAGNITUDE	MEAN μ	NUMBER OF STARS
	km. *km.*			
B–B5........	0 to 2.9	3.8	0.031	58
	3.0 5.9	4.0	0.024	47
	6.0 9.9	4.2	0.025	42
	10.0 19.9	4.4	0.029	24
	10.0 19.9	4.4	0.025*	23
	20.0 25.6	4.6	0.024	9
A...........	0 to 5.0	4.3	0.083	68
	5.1 9.9	4.2	0.104	49
	10.0 14.9	4.3	0.091	31
	15.0 19.9	4.4	0.112	27
	20.0 29.9	4.1	0.074	27
	20.0 29.9	4.5**	0.066	22
	30.0 35.5	4.7	0.068	8

* Omitting one large value.

** Omitting five bright stars.

TABLE III

	CLASS B–B5		CLASS A	
	Number of stars	Mean μ	Number of stars	Mean μ
1.9 and brighter	11	0″.051	8	0″.382
2.0 to 2.9	18	0.033	19	0.177
3.0 3.9	38	0.028	26	0.093
4.0 4.9	88	0.024	121	0.075
5.0 and fainter	24	0.025	38	0.066

of velocity in all three classes *near the smallest proper motions.* An examination of the results of Kapteyn and Adams indicates somewhat similar rather sudden increases in velocity in the classes F, G, and K, but in proper motions somewhat larger than in the B and A stars. Such an effect is not noticeable in the M stars. The application of a magnitude velocity correction would tend to reduce the peculiarity slightly.

As these velocities (V_1) for the B stars had been derived by including the constant error K, it was decided to see what the effect might be of neglecting it and using $V_1 = -19.5$ km., the same solar motions as were used in obtaining results for the A stars. The fifth column (V) contains these results. The general decrease of velocity with increasing proper motion is still indicated rather uncertainly but the sudden increase of velocity alluded to has been reversed in the B–B5 stars. This reversal seems to result chiefly from the application of K to the small negative velocities in the two groups.

It seems rather curious that this peculiar maximum in the velocities shifts about with the term K – where a considerable value has been found for it, the maximum and peculiar sudden increase of velocity are shown only if it is used. On the contrary, where no K term resulted, the maximum and sudden increase show with its omission. If confirmed, this indicates a relation of some sort.

The parallactic motion of the Sun is very noticeable in the proper motions of both the B and A classes and it seems not improbable that some systematic effect may have crept into the velocities when classified according to proper motions which have not been freed from the solar motion—that the peculiarities observed may be due to a preference of the faint stars and those of larger velocity for certain regions of sky.

The dependence of velocity upon magnitude is clearly shown in both classes B–B5 and A in the above classifications particularly in the residual radial velocities of table II. The effect of the few apparently abnormal velocities of bright stars in class A is here very marked also.

An examination of table II shows that in B–B5 stars with the possible exception of the smallest radial velocities (very brightest stars) there is little or no connection of the proper motion with the radial velocities. There is, however, a peculiarity in the case of the class A stars—the largest proper motions being associated with velocities of medium value. The largest velocities of all show the smallest proper motions—even after making liberal allowance for a magnitude-velocity effect. Until systematic effects such as magnitude-velocity equation, constant error, etc., are better understood, it seems useless to attempt a discussion of such small peculiarities. It seems probable, however, that the velocity distributions in these two classes may not depart widely from Maxwell's law, but that they are different from those in the spectral classes F, G, K and M.

Conclusions.—1. The radial velocities of the stars of classes B and A appear to decrease in general with increasing proper motion. There are, however, some inexplained anomalies.

2. The velocity distributions of classes B–B5 and A differ from the distributions found for the F, G, K and M classes by Kapteyn and Adams, appearing to be more clearly in accord with Maxwell's law.

3. The effects of the magnitude-velocity equation are clearly shown in the classification of the B and A stars made for this investigation.

4. There are some indications of a small abrupt change in the velocities of both classes in the smaller proper motions. There are also some indications in the classes F, G and K of such a change but in proper motions somewhat larger than in the early classes.

[1] *Astrophys. J.*, **41**, 318.

[2] These PROCEEDINGS, **1**, 14.

ASYMMETRY IN THE PROPER MOTIONS AND RADIAL VELOCITIES OF STARS OF CLASS B AND THEIR POSSIBLE RELATION TO A MOTION OF ROTATION

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In the course of other investigations asymmetry in the proper motions of the B stars was suspected. A preliminary investigation has shown a systematic difference between the proper motions in the region about 0^h and that opposite. The results of a comparison of the proper motions in these two regions and also with the regions within 40° of the apex and the antapex of solar motion are given in the table. The average radial velocities of the stars (V_2) are also included.

An examination of the individual values shows a marked consistency in all of the regions. These results depend upon Campbell's catalog of class B stars in *Lick Observatory Bulletin*, No. 196. As is well known these stars have a marked preference for the Milky Way.

The minima corresponding to the apices of the solar motion fall at $6\frac{1}{2}^h$ and 19^h. The two maxima corresponding to the parallactic motion of the Sun fall at 2^h and $13\frac{1}{2}^h$. These two points are almost exactly at right angles to the direction of the Sun's motion.